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ABSTRACT

Focusing on the social aspects of new technologies, this report presents the conclusions drawn and recommendations made by a group of individual experts with wide experience in industry, labor relations, academia, or public service, who were charged with examining the potential importance of the new technologies for growth, jobs, and welfare, and reporting on their national and international implications both for employment and for society. The report examines nine complex and controversial issues dealing with technological change as a social process: (1) the need for a socioeconomic strategy for new technologies; (2) elements of the strategy; (3) flexibility in the enterprise; (4) a responsive education system; (5) the creation of more opportunities; (6) increasing the flow of investment; (7) expanding the markets--international aspects of the strategy; (8) a new pattern of research, development, and design; and (9) the role of constructive technology assessment. Discussions of these issues take into account economic as well as social and human factors, and pay attention to the increasingly interdependent nature of the global economy in terms of dealing with policy issues. Following the analysis of each issue a unanimously agreed upon recommendation is offered. These recommendations call for action by a wider range of governmental and non-governmental groups, including policy makers and other authorities. (CGD)

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New Technologies in the 1990s

A Socio-economic Strategy

Conclusions and Recommendations
of a Group of Experts on the
Social Aspects of New Technologies

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PREFACE

High unemployment in OECD countries, especially in Europe, and its concentration among certain groups, has focused attention on the need for structural reforms. This need is reinforced by technological change which not only offers new potential for work opportunities but is, simultaneously, a key agent of structural change. Hence, the advent of several new technologies has been greeted by some as offering the panacea, while by some others as further complicating the process of adjustment. The variety of conflicting views expressed on the subject argues for careful analysis.

These considerations led the OECD Ministers of Labour, when they met in November 1986, to ask me to set up a Group of distinguished experts to examine "the great potential importance of the new technologies for growth, jobs and welfare", and to "report on their national and international implications both for employment and for our societies more generally". On their advice I set up the Group under the chairmanship of Mr. Ulf Sundqvist, Chief General Manager, Labour Savings Bank of Finland, former Minister of Education and former Minister of Industry, Finland. The members of this Group were people with wide experience in industry, labour relations, academia or public service. They served in their capacity as individuals: their Report does not commit OECD governments.

The Report examines a set of complex and controversial issues. It makes an important contribution in recognising the economic and welfare potential offered by the new technologies by stressing that technological change is a social process. If not accompanied by appropriate structural and institutional reforms together with a satisfactory rate of investment, it may fail to contribute to the extent it should to higher levels of jobs and welfare. In coming to policy conclusions the Report rightly takes into account economic as well as social and human factors, and pays attention to the increasingly interdependent nature of the global economy. It is especially noteworthy that the Group has produced a set of unanimously agreed recommendations, which call for action by a wider range of governmental and non-governmental groups, including policy-makers representing enterprises, business and labour organisations, and the authorities dealing with education, labour market, regional issues and international co-ordination.

The Report promises to be a valuable input to the OECD's continuing work on technological change and structural adjustment. I will be bringing it to the attention of Member governments. I believe that its analysis and recommendations will be found important and will be widely debated by policy-makers among business circles, trade unions, educationists and governments.

I have accordingly, on the recommendation of the OECD Manpower and Social Affairs Committee, decided on its early publication. The policy conclusions and recommendations are being published in advance; the full Report which includes, in addition to the policy conclusions and recommendations, five chapters of supporting analysis, is to appear later.

Jean-Claude Paye
Secretary-General of the OECD

Letter of Transmittal

Dear Mr. Paye,

Last July you set up a Group of distinguished experts, under my chairmanship, with the mandate to examine the national and international implications of the new technologies on employment and on societies more generally. It is with great pleasure that I herewith submit to you the Report of the Group*. I am happy to report that the Group has reached unanimity on the policy recommendations it makes.

I would like to thank the members of the Group for the varied and rich expertise and the wisdom they brought to bear on a set of extremely complex and controversial issues. Their diligence and co-operation made it possible to prepare a report of this magnitude in such a short time. Our efforts, it needs to be stressed, would not have succeeded without the competent and unfailing support we received from the Secretariat.

Ulf Sundqvist
Chief General Manager
Labour Savings Bank of Finland

* Other members of the Group were: Mr. Sigfried Bleicher (Board Member, I.G. Metal, Germany), Professor Renato Brunetta (University of Venice, Economic Advisor to the Minister of Labour, Italy), Mr. Frank Doyle (Senior Vice-President, General Electric, United States), Professor Chris Freeman (SPRU, University of Sussex, United Kingdom), Professor Jean-Jacques Salomon (Director, *Centre Science, Technologie et Société*, CNAM, France), Professor Haruo Shimada (Keio University, Japan) and Professor Luc Soete (Director, MERIT, University of Limburg, Netherlands). Mr. Abrar Hasan of the OECD Secretariat served as secretary to the Group.

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A. INTRODUCTION

Technological Change as a Social Process. The starting point of our report is the interdependence of technical, economic and social change. Technological change is often equated either with certain hardware, or with specific production processes; this is a mistake. Technological change is, in its development and application, fundamentally a social process, not an event, and should be viewed not in static but in dynamic terms. That it is a social process is demonstrated by the useful distinction between pervasive technologies, such as the information technologies (IT), which have an impact throughout the economic system, and others, whose impact is principally on particular firms or individual sectors. Pervasive technologies cannot be imposed on our societies; they have to be introduced through institutional adaptation and a process which mediates between differences of interest.

The Importance of Wider Environmental and Societal Considerations. As living standards have improved in OECD Member countries, concern has grown about the quality of products and services, the quality of work, about environmental conservation and improvement, and the quality of life more generally. These issues require systematic consideration and public debate preferably in the form of institutional innovations such as "Technology Assessment". This is not to minimise the importance of productivity growth, which is essential, not least to ensure the availability of resources for environmental improvements.

Features of the Structural Break. We have concluded that information technologies represent a key structural break, and offer considerable productivity potential. We found the following arguments particularly persuasive. First, IT, based on a cluster of interrelated innovations in micro-electronics, computers and telecommunications, is an extraordinarily pervasive technology. Potentially it can be used in all sectors and in all functions; in factories, and in offices, as well as in homes. Second, many studies suggest that productivity gains can be substantial, thanks to an unprecedented rapid decline in costs. Third, information technologies are the fruit of a rich collection of inventions, which means that R&D productivity is shifted on to a new and higher trajectory. Fourth, the productivity potential of IT is further enhanced when considered in conjunction with other technological developments, particularly in materials and bio-technology.

Emerging Disequilibria. These characteristics of IT generate various types of disequilibria, sometimes characterised as disequilibria "both in time and in space". These may arise within countries; and also between them. The pattern of job creation and job destruction will normally be unevenly distributed from one region, industry or occupation to another, and, if unchecked, may encourage dualism in society. The "virtuous circle" of innovation, growth and employment might be weakened if the transition costs during the process of job destruction and job creation turn out to be unacceptably high.

B. THE NEED FOR A SOCIO-ECONOMIC STRATEGY FOR NEW TECHNOLOGIES

The Importance of the Productivity Dividend. Technological change is one of the key determinants of long-term job growth and social progress. Historically, rising output in the industrialised countries has gone hand in hand with rising employment and growth of labour productivity, the latter attributable in large measure to technological change. Rates of unemployment tend to be high in periods of low productivity growth, such as the inter-war years and the 1970s, and low in periods of high productivity growth, such as the 1950s and 1960s. The productivity growth made possible by technological change is in the nature of a dividend, which can increase both profits and labour incomes. In the latter case, it can be distributed in the form of better wages, hours and working conditions. In other words, improvements in labour productivity permit sustained improvements in wages and working conditions as well as improvements in the quality of life and the availability of leisure over the long term.

Realising the Potential is not Automatic. That a technology has a potential is, however, only part of the story. To be socially relevant the potential must be translated into actual productivity gains, and thus into higher rates of output, earnings and employment. Puzzlingly, despite its productivity-enhancing potential, IT has been slower to enter some industrial sectors than expected, and has often failed to show up in measured growth rates of aggregate productivity. Far from diminishing the significance of IT, these paradoxes should be explained mainly in terms of the interdependence of technical, economic and institutional change. The factors responsible for the low take-up rates and the poor productivity performance need to be identified. The obstacles to realising the productivity potential also constrain the diffusion of these technologies. It is in these areas that the need for a strategy resides.

Objectives of a Strategy for New Technologies. In the economic and social context outlined above, policies would aim at sustained non-inflationary economic growth such that full-time or part-time work is available for all who actively seek it (the "active society"), and the emerging dualism in the labour market and society is avoided. This is a necessary pre-condition for attaining other social goals. Taking into account the increasingly interdependent nature of the global economy, the growth of OECD nations' needs is best achieved in concert with development elsewhere, so that a virtuous circle of economic and social growth is sustainable. Consistent with this, Member countries should adopt a long-term strategy of continuing innovation, both technical and social, in order to safeguard and strengthen their own growth potential as other (formerly Third World) countries catch up with the technological leaders in OECD. Furthermore, they need to take into account not merely the quantitative growth of per capita GNP, but also the wider environmental and societal issues involved with any major new technology.

Who is to Take Action. These objectives have shaped the strategy elaborated in this Report. The Report is forward-looking; it takes the 1990s as the reference point. It is based on emerging, rather than firmly established, trends. While the policy package it presents is mainly geared to governments, it emphasizes the role played by various groups in a democratic society. The recommendations it contains are, moreover, mutually supportive. Individual Member countries would undoubtedly each place different weight on the various components. The policy package therefore aims to exploit the high degree of interrelationship between the

policies and actions of the various authorities and organisations, since efforts directed to achieving one target also help attain others.

RECOMMENDATION

We stress the need for a long-term socio-economic strategy for new technologies. By this we mean a set of interrelated policies which take into account that neither the technical, nor the economic, potential of major new technologies can be fully realised without concomitant, even anticipatory, social and institutional changes at all levels in society.

C. ELEMENTS OF THE STRATEGY

Continuing Innovation. The focal point of the proposed strategy is the generation and maintenance of advanced capacity for continuing innovation, both technical and social. Its two key requirements are advanced R&D capacity, and social and institutional innovations to facilitate rapid diffusion. These requirements can be satisfactorily achieved only through a high rate of investment, both physical and intangible, and a socio-economic environment favourable to change. Investment is crucial, since it is via this mechanism that new technologies become embodied and diffused. A high degree of confidence is necessary for the climate in which the necessary investment can take place and its productivity be realised.

New Rules of the Game. A climate of confidence for the successful introduction of new technologies requires what may be described as "the comprehensive innovation process" – innovation in a broad range of activities and processes. The spectrum includes not only the enterprise and the market, but also the rules of the game as set by society through its various organs. Hence, entrepreneurship, management, work organisation, financing, the opening up of markets, worker and employer organisations, labour market, educational and regional authorities, etc., are all involved. We believe that the more radical the nature of technological change, the more profound and complex the social interaction it generates, and the more innovative institutional changes it necessitates. A good example is in the whole sphere of new information services and networks based on telecommunications and computerised data banks. Without these services the productivity benefits of the new technologies are unlikely to be satisfactorily realised. It is sometimes forgotten that markets are themselves social institutions operating within a specific legal framework, requiring standards and norms as well as tacit and implicit behavioural rules to give confidence for new investment.

New Rules and the Role of Market Forces. In this perspective, the role that markets play can be crucial: they are best suited to the allocation of resources and the picking of winners in the short term and medium term. However, markets work best when the rules of the game under which they operate are appropriate. The introduction of radical new technologies necessitates changes in the rules of the game and other long-term allocative mechanisms. While market pressures can help, they are not sufficient to bring about the required changes.

A smoothly functioning market is a necessary, but not a sufficient, condition for accelerating the pace of diffusion and achieving the desired distributional effects; institutional innovations provide the necessary complement.

Important Choices. Important choices have to be made, because institutional and attitudinal changes are not easy to accomplish. Some of these choices may be more acceptable than others, and this Report is directed to examining them. While important conflicts of interest may precede and accompany technical change, its introduction can confer benefits on all parties. Different societies have gone about adjusting to the new technologies in a variety of ways, and with markedly different effects. The assessment of the successful cases and of their potential application in different institutional set-ups could be an important role for international organisations. The international dissemination of best-practice productivity is an important aspect of the sustained growth of the global economy, as was particularly evident in the recovery and rapid growth of the OECD economies after the Second World War.

RECOMMENDATION

Since the international dissemination of best-practice productivity is an important means to achieve sustained and balanced growth of the global economy, we recommend a careful assessment of how different OECD economies have successfully adjusted their institutions and labour market practices to new technologies, with a view to stimulating similar adjustments in countries with a different institutional set-up. A comprehensive statistical data base needs to be developed for the assessment. The idea of an OECD-based Productivity Movement should be revived, to instigate an international learning process about best-practice application and diffusion of new technologies, taking into account the specific characteristics of these technologies.

D. FLEXIBILITY IN THE ENTERPRISE

The Micro Level is Decisive. The performance of any socio-economic system depends ultimately upon the capability of management and workers at the enterprise level. The full exploitation of the new technologies implies a shift from the "Tayloristic" model of production organisation which dominated the first half of the century, not only in manufacturing but also in the services and public administration, to a much more decentralised organisational structure which emphasizes a two-way flow of information. Traditionally, efficiency and control were the twin objectives of management, but two new features have been introduced with the advent of the new technologies. First, the high cost of some of the new equipment means that incomplete or poor use can be extremely costly. Second, short commercialisation cycles and the associated tendency towards shorter production cycles mean that the enterprise

has to be more responsive to emerging markets. Considerable advantage can be gained here through greater worker participation. The key to achieving this is commitment of management to establish close working relationships between managers, engineers and workers. New technologies can help to broaden the area of mutual interest in enhanced responsibility and involvement of workers. At the same time they offer a wider choice in decentralising the management, production, marketing and design process.

Big Changes in Occupations and Skills. The requirement of changes in management thinking has important implications for organisational and skill structures. From a typical pyramid-shaped structure the move is towards a substantial upgrading and broadening of skills. Narrowly-defined job categories have to be replaced by broader job classifications, so that workers are provided incentives in the form of on-the-job learning opportunities. Payments linked to individual competences, rather than to output, and to the performance of the enterprise as a whole, can provide incentives for workers to acquire new skills and thus help encourage redeployment and job redesign.

New Patterns of Working Time and Worker Involvement. There are other areas too of mutuality of interest between managers and the workers. New arrangements can be devised whereby work schedules both correspond to the aspirations of the labour force and make intensive use of expensive capital equipment. The basic approach requires managers, workers, and their representatives at enterprise level to confer in the early stages of introducing new technology; superficial participation or bureaucratic forms should be avoided. The realisation is dawning that this can be in the interest of all, even in the early stages of design and development.

A Changing Pattern of Union and Business Organisation. To achieve the hoped-for results, both workers' and employers' organisations will need to review their traditional structures. Unions may have to examine craft boundaries – as they already have in several countries – and perhaps modify their structures to ensure that, while solidarity of interests is maintained, there is no serious impediment to the adoption of new technologies. Employers should look beyond the collective bargaining, whether in the enterprise or in the industrial context, and foster new regional approaches as well as collaborative arrangements with other enterprises and public institutions in such areas as research, training and communication networks.

RECOMMENDATION

In enterprises and other productive organisations the effective implementation of technological change requires a strong commitment by management to deepen the involvement of those affected by new products, processes and systems. Broadly speaking this means in many instances a shift from "Tayloristic" patterns of organisation, with their fragmentation of work tasks and layers of supervising management, towards multi-skilling and the devolution of responsibility. Such change will require the retraining both of managers and of workers. It also means a trend towards the "horizontal" integration of departmental functions within the enterprise, and the interchange of information throughout the enterprise, from the earliest stages.

E. A RESPONSIVE EDUCATION SYSTEM

The Need for Flexibility and a Broad-Based Education. We insist on the crucial supportive role of the education system. Action is indicated in several areas. The education system needs to provide workers with an adequate basis for the later acquisition of new skills, and to facilitate the movement of workers between industries, occupations and employers. This implies a more flexible response by the education authorities to the changing pattern of occupational skills, but above all a higher minimum threshold of competences for all young people if they are to compete in the fast-changing labour market. These competences provide the basis for long-term flexibility, and should be combined with subsequent training opportunities which facilitate transition into working life and provide an adequate supply of creative and highly-qualified people. To achieve the necessary degree of responsiveness in the education system, teachers themselves have to be retrained. And major investments in higher education are needed to underwrite the needs of a high and rising R&D capacity of the economy and to sustain the essential base in fundamental research.

Changing Work Requirements. Education and training systems will increasingly be required to meet the demands of modern production processes. New technology tends to change work organisation and job content towards greater emphasis upon qualities like teamwork, initiative, creativity, entrepreneurship, problem-solving and openness to change. Many of these characteristics cannot be developed from scratch at the workplace but depend, to a large extent, on appropriate education and socialisation experienced particularly in schools.

Impact on Education Practice. New technologies, in particular the new information technologies, can free teachers from the constraints of time, space and large classes. They can cut costs and increase teachers' productivity. Education systems face the challenge of combining the best in traditional methods with the modern.

The Need for Enterprise-Level Training. There is a wide variety of training systems in OECD Member countries with different combinations of public and private provision. Smaller firms often lack the resources to organise training, but in general it is often advantageous for firms to complement the public system with their own specific training programmes designed to meet their own changing requirements. This helps foster good industrial relations and communication within the firm. OECD could perform a useful role in making good the lack of internationally-comparable statistics.

Education and Training throughout Life. Adults seeking to requalify themselves for entirely different occupations cannot succeed without further training and education. This requires improved co-operation between education, enterprise and the trade unions. The reforms now being contemplated in Member countries should benefit from open dialogue between the educational establishment and all the parties that have a stake in educational outcomes, including the social partners as well as labour market and regional development authorities. An active society requires education and training throughout life.

RECOMMENDATION

Technological change cannot be realised without concomitant, even anticipatory, changes in the education and training system, to meet the requirement for a more highly-skilled and educated workforce. It is necessary to develop more flexible types of course provisions, both within enterprises and in the higher education system. A broad general secondary and tertiary education for large numbers of young people needs to be complemented by more specialised adult courses throughout working life, sometimes in industry, sometimes in educational institutions, and sometimes in combined courses. Teachers will need frequent retraining. Educational methods and pedagogy should be further developed to foster initiative, creativity, and responsibility among young people in order to better prepare them for the new conditions at work. These efforts will carry considerable costs. While there is a variety of financing practices in Member countries, we believe that, as a matter of principle, the employer – not just the State – should carry a major responsibility for retraining workers to enable them to use new equipment and procedures.

F. CREATING MORE OPPORTUNITIES: THE ACTIVE SOCIETY

The Notion of the Active Society. The post-war period of strong economic growth permitted the building of the welfare state on a solid basis of full-employment. An economically active part of the population was able to generate the necessary resources to finance rising standards of well-being for all, both the economically active and the non-active. Large-scale and persistent unemployment, with the ensuing costs to society of unused human resources, social stigma and decaying skills, have raised fundamental questions about social organisation, the role of the individual in society, and society's responsibility to the individual. The post-war model is likely to be put under further pressure by the ageing of populations. A third challenge could be a change of individual preferences away from contentment with income support, towards active involvement in the productive system. A new model should therefore be considered: an "active society", in which policies are designed to help as many people as possible to play a positive role, in which they can perceive themselves and be perceived as making a useful contribution to economic and social life. Paid employment in the market would still be the principal form of contribution, but it could take new and more varied forms. The new technologies, with their fundamental impact on the world of work, will facilitate this change if their introduction is accompanied by changes in work organisation, new working time arrangements, and new opportunities for education and training.

New Patterns of Work. These considerations suggest the need for a new concept of full employment. Full employment cannot realistically mean a 40-hour work week (or a 35-hour work week) for everyone up to the age of 60 or 65, and the exclusion or marginalisation of all others from this privileged group. It must rather be defined in terms of the right of people to make an active contribution to society at all times with a varied length of working week, working day and working year, depending upon their preferences, their family and life circumstances, their education and training. To achieve this, public policy will have to play an active role in creating new opportunities. Work fulfils many functions in addition to income maintenance: it provides dignity, social recognition, a focus for people's lives, meaningful social relationships and purposeful activity. Less-than-full-time work schedules can be desirable for the elderly, for mothers and fathers, for young people, indeed for all who wish to make an active contribution to society. However, the danger is that a dual labour market might relegate these part-time participants to an inferior status. To avoid this will require much imaginative thinking by employers, by unions and by public authorities, as well as changes in attitudes in society more generally. Among other things, new training opportunities should be available which can facilitate the mobility of workers between the varying roles which are now potentially available in the labour market.

Alternate Working Time Arrangements. Independently of changes in technology, demands have been growing from workers for more flexible working arrangements. This coincides with a growing demand for flexibility from employers, who wish to vary labour input in response to fluctuations in product demand, and from consumers, who wish for example to profit from non-restrictive shop hours. Recent experience has shown that the desires of the various actors are often difficult to reconcile, especially concerning weekly and annual working-time arrangements. Nevertheless, the considerable capacity of the new technologies to increase the range of modes of production and forms of work organisation should encourage both sides of industry to carry on negotiations for appropriate arrangements, and should induce governments to support this process.

New Jobs in Services, Particularly the Information Sector. We have argued that many new full and part-time jobs could be created by a wave of new investment associated with the worldwide diffusion of the new technologies. But this depends upon enhancing productivity growth, particularly in the service sector, and upon the generation of new types of service activity. We believe that when the new technologies are introduced in the service sector, they will generate a process described as a "reverse product cycle" whose culminating phase is characterised by product innovations through the generation of new types of services – services so different in nature and mode of delivery from more traditional forms that they can be described as new service products. These new types of service industries, based primarily on information, knowledge, and education sector activities have major job-generating potential. Examples can be found in home banking and shopping, network information services for domestic and business users, computer-aided education and training, and expert systems for medical diagnosis. New service sector jobs could also be created in response to extended leisure activities and alternative work schedules. Examples are the cultural sector, the preservation of nature and the environment, urban renewal and the maintenance and redeployment of the existing public infrastructure.

The Revitalisation of Traditional Industries and the Creation of Small Firms. There are already many examples of applications of information technology which have led to the survival or rejuvenation of old established industries. While the total number of jobs often had to be reduced, many jobs have been preserved, and job security improved. In order to minimise

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job losses, restructuring must be done as early as possible. As part of the same restructuring process many new, small firms are often created, the new technologies making small batch production more profitable. To be successful in the market requires that these new, small firms take over some of the functions of existing firms, whether by clustering production in new ways or including new functions and supplying new products. There is a need for a broad shift of government support from existing firms with established positions towards entrepreneurship in its formative stages and towards infrastructural and intangible investment. Growth of small firms and their geographical dispersion also depends importantly on there being in place appropriate telecommunications infrastructures in networking, as well as on availability of venture capital and community services.

Regional Policies and New Employment. There may be an initial tendency for the new technologies to exacerbate regional disparities because the necessary human capital, institutional framework and social attitudes tend to be concentrated in already dynamic areas. However, at the same time the new information technologies weaken the hold of traditional factors on location decisions, and offer the opportunity for more decentralised economic activity whenever the technology-induced reduction of information and communication costs, and lower land prices offer more substantial savings than the increase of transportation costs resulting from decentralisation. Regional, educational, urban and rural development policies should be changed so as to foster the skill, entrepreneurship and social infrastructures which foster local resources to promote indigenous development. There are several examples in which the supply of relevant, technology-intensive skills at local level has led to the creation of new economic activities and local development.

RECOMMENDATION

Social innovations are required in order to translate technology-induced productivity gains into higher employment. The "active society", in which all members are equipped for, and can perceive themselves and be perceived as, making a useful contribution to economic and social life, should become an objective of public policy. The new technologies could contribute to the achievement of this objective. They have the potential to facilitate the wider application of alternative work schedules, to foster job creation in response to new service needs and through the maintenance and redeployment of the existing public infrastructure in such areas as education, information, environment and urbanisation, to revitalise old and traditional industries, and to create new economic opportunities for small firms.

G. INCREASING THE FLOW OF INVESTMENT

Interdependence of Tangible and Intangible Investment. The key to job generation is a greater flow and appropriate spread of investment. Both physical and intangible capital have to be augmented. The potential of physical capital to create jobs will be realised only if it is matched by sufficient and appropriate investment in the skills of the labour force. The flow of investment depends on a variety of conditions, notably entrepreneurship and profitability. Again we stress the interdependence of our proposals. While new technologies have opened up options for small, decentralised entrepreneurship, the exploitation of opportunities has so far been limited by inadequate networking and infrastructures and the limited supply of skills and venture capital. Innovative approaches to financing and governmental and community support for infrastructure development can play a significant role in stimulating entrepreneurship. Member countries differ considerably in the institutions providing for venture capital, and much can be gained by sharing successful experiences. Education is also important; while it may be inherently difficult to teach entrepreneurship, the education system can help to foster the entrepreneurial spirit.

Raising the Level of Investment. Meeting the demands of markets engendered by the new technologies will require major investments in physical capital. The requisite amount of additional investment over the next several years is likely to be several percentage points of national income, especially in Europe. Resources on such a scale will not in most cases be freed through reductions in public expenditure and will have to be generated through some moderation, at least for a period, in the rate of growth of per capita consumption. This may prove more acceptable when the public identifies it with the investment in education and training that raises the productivity and incomes of workers – investment which, by its intrinsic nature, employees carry with them when they change jobs. The general public, including labour, should be encouraged to participate in an investment drive, through profit sharing, investment and pension funds and other creative ways of financing job-creating investments in the private sector. The widening of capital ownership, including co-operative ownership, is important in this policy. In the past, co-operative ventures have often failed through lack of relevant management skills and experience. The far greater pool of skilled and experienced people today and the general rise in levels of education have created a new and more favourable basis for these ventures.

RECOMMENDATION

Special attention should be given to creating an investment climate in which decisions to augment physical capital go hand in hand with decisions to augment intangible capital. The creation of work opportunities on a scale sufficient to make inroads into unemployment requires moderation in the growth rate of per capita consumption in order to provide funds for the additional investment needed in such areas as infrastructure and human resource development. Traditional modes of savings need to be supplemented by new approaches. Various forms of profit sharing and the spreading of capital ownership should be encouraged in order to win not only the support but also the active participation of the general public, including labour.

H. EXPANDING THE MARKETS: INTERNATIONAL ASPECTS OF THE STRATEGY

An Expanding World Market. The sustained growth of the world economy is a necessary condition for the success of national strategies for employment, investment and technical change, and a global recession would represent perhaps the most serious threat to the success of these policies. Major efforts will be needed to ensure a continued growth of international markets. Experience in the 1950s and the 1960s showed how rapidly incipient technological gaps between Europe and the United States were narrowed by concerted international action to reduce barriers to free trade, international investment and the flow of knowledge. Governments have a responsibility to maintain and extend this framework. This implies not only the effort to fight protectionistic tendencies, but also, taking a longer-term view, to extend the possibilities of market growth outside the OECD and to co-ordinate growth policies.

International Policy Co-ordination. The economic interdependence of OECD countries, and of the global economy more generally, will progressively reduce the scope for individual countries to influence and regulate the pace of introduction of new technologies. This does not imply, however, that countries exposed to international competitive pressures will have passively to "endure" the consequences of change. What is required is the design and pursuit of policies which influence and regulate the response to change. This in turn requires a heightened awareness of the direct and indirect implications of technological change and the development of appropriate policy instruments which can best be summarised as the "social management of change".

Disequilibria, International Co-operation and the Role of International Institutions. New initiatives may be necessary to ensure the harmonisation of economic policies and to prevent current international disequilibria degenerating into a downward spiral. Different capabilities in the OECD countries for overcoming institutional and social obstacles may result in increased disequilibria and widening technological gaps. The OECD and other international institutions should foster co-operation to limit the risks of emerging dualism among countries. This applies especially to the international indebtedness problems of many Third World countries. Furthermore, it should be recognised that the less developed countries will be unable to catch up without a major breakthrough in the accumulation of intangible capital, notably skill formation. It is in the self-interest of the industrialised countries to assist them in improving the specific capabilities of adopting new technologies so that they can participate more fully in a process of balanced world economic development.

The Newly Industrialised Countries. It is necessary to take into account the very different circumstances of Third World countries. Large economies such as Brazil and Mexico could join the ranks of the NICs as a competitive force in world markets for sophisticated manufacturing thanks to their relatively advanced infrastructure and their intangible investment in education and research. China and India, although still facing enormous problems of infrastructure, organisation and human resource development, may also eventually follow. In this period of radical, paradigm change, the probable advance of some large economies offers a big opportunity for sustained growth in world markets. A combination of low labour costs and new technologies could give them powerful advantages in contrast to the technologically backward developing countries, whose prospects on world markets are increasingly precarious. The competitive position of the OECD countries can be

safeguarded only through a conscious strategy of continuing innovation and change. Access to OECD markets' investment and technology could be shared in exchange for new markets in the emerging NICs. This strategy should help foster a mutually supportive and more stable world.

The Soviet Union and Eastern Europe. Nor can the Socialist countries be left out of consideration. As they struggle to overcome their internal problems there may be many opportunities for mutually beneficial exchanges in trade and technology, which could contribute greatly to a prosperous and expanding world economy and, through the relaxation of tension, to arms reduction.

RECOMMENDATION

A socio-economic strategy for new technologies would not succeed without an expanding world market. Extended trade flows between the OECD area and the NICs as well as the Socialist countries would benefit all, including indirectly the less-developed countries. However, for the latter group of countries more is needed in terms of technology co-operation and the transfer of know-how from the highly-industrialised countries. We believe that these countries should be assisted by the industrialised countries to build up their stock of human capital and social infrastructure to enable them to participate in balanced world economic development.

I. A NEW PATTERN OF RESEARCH, DEVELOPMENT AND DESIGN

A New Pattern of Integration for Research and Development. The expansion of markets depends on new products and processes, and thus on R&D. The new technologies, especially information technology and bio-technology, have close and continuing links with fundamental research, reflected in the expression "basic technology". A number of governmental and intergovernmental programmes are now concerned with the links between basic science and generic technologies. A new pattern of funding is emerging, which seeks to bridge the divide between the academic and the industrial research communities. Information technology itself facilitates the development of links. At the same time, horizontal communication within the enterprise itself between research-development, design, production and marketing becomes more important. "Taylorism" is obsolete not only in production but throughout the enterprise. Vertical command structures are yielding to horizontal information interchange. The trend

towards reintegrating R&D with the other functions of the firm while reducing departmentalisation and specialisation corresponds in our view to a trend in society at large.

Over or Under-Investment in R&D? Fundamental research has long been regarded as a special case, justifying substantial public support where the long-term social benefits exceed the scale of private investment. The general response to the traditional policy question, "Is there market failure or suboptimality in science or technological effort?", is that market failure is indeed one of the intrinsic characteristics, but this does not carry the discussion very far. Indeed, these arguments have on occasion led to the justification of big national and international R&D projects financed and planned directly by state and government agencies, and have thereby become some of the most dramatic illustrations of "government failure". The complexity of the problems involved suggests that general principles and statements about the appropriate roles and relative merits of governmental and private activity in the field of R&D policy will neither describe the experience accurately nor provide much normative guidance.

A Strategy for Technology is More than a Policy for R&D. Since technological and social change form an integrated process, the diffusion and management of innovations can no longer be treated as the Cinderellas of technology policy, but need to be treated as an integral part of technology policy. For this reason our Report does not concentrate on the purely quantitative aspects of R&D expenditures, although these continue to be important. Policies affecting technological change need to encompass more than just R&D and embrace the entire spectrum of scientific and technological activities from invention to diffusion, from basic research to technological mastery. For this reason we stress again the complementarity of our various proposals relating to education, skills, investment, and work organisation.

Enhancing Technological Capabilities. We are not concerned with recommending big increases in expenditure on particular projects or programmes, although we do believe that the problem of fundamental research needs some attention. Rather, we are concerned with the effectiveness of the social systems which generate and diffuse technical innovations, and with the social integration of technological change, within firms as much as within society at large. The creation of technological capabilities involves an endogenous process of change, "mediated" with society at large, and this implies that policies in the area of science and technology will not be, nor should be, limited to questions about the economic "integration" of technological change. Economic, but also social and ethical, factors will increasingly determine which technical innovations will be adopted, or even selected. It is in this context that the discussion of the work environment and industrial relations finds its proper place.

RECOMMENDATION

Technological innovation and social change must be seen as an integrated process and should be managed as such. The diffusion and management of innovation must be an integral part of any technology policy. Policies for technological change need to encompass more than just R&D, to give prominence to the labour market, the education system, enterprises and the various other social aspects which our report highlights.

J. TOWARDS A BROAD-BASED CONSENSUS: THE ROLE OF CONSTRUCTIVE TECHNOLOGY ASSESSMENT

The Need for Constructive Technology Assessment. We have so far considered mainly the issue of worldwide diffusion of information technology. The social nature of the process of technological change is illustrated even more clearly by bio-technology. These technologies have important impacts on the processes of birth, death, crime and disease detection and prevention. They raise important environmental and ethical issues which are likely to bear on the prevailing values of society. The costs and benefits they generate can potentially be large, and their incidence may differ significantly for different groups in society. Hence, there is need for analysis so that the mismatches, the wrong investments and possible social conflicts can be minimised, while at the same time the beneficial effects and opportunities can be fully exploited. It is in this context that we view the issue of technology assessment: as a means of informing the people concerned, generating constructive public debate and encouraging public understanding and involvement. Parliaments do not have the time, the resources or the expertise to explore many of the complex issues involved. Institutional arrangements in OECD countries vary a great deal, but we would see some link with the elected legislature as an essential feature of technology assessment.

Assessment is a Continuing Process. From the perspective adopted in our Report, the long-term implications of technical change, the "externalities" in economists' jargon, will generally speaking not be susceptible to definitive once-for-all categorisation, but rather be more intimately related to particular historical and institutional contexts. Processes of change are continually creating new "externalities".

Technology Assessment and the New Strategy. The current policy debate about some of the long-term, international "externalities" of technological change – its impact on the environment (air, land and water pollution), on privacy and on society's future genetic capital (genetic manipulation, pre-embryo research) – create the need for technology "assessment" and institutional experimentation in science and technology. Governments face a major challenge: how to assume the State's function as social "creative" regulator of technical change in a period of deregulation, itself aimed at stimulating further innovation. It will be tempting, but wrong, to equate the need for "less State" with the notion of "technological laissez-faire". Government science and technology policy is at a crossroads. The policy trajectory which has survived over the last 30 years, with its almost unique focus on R&D, needs to have its boundary lines redrawn. These lines will be broader, less minimalistic, and less "market failure" inspired than they appeared at the outset. They involve a new phase of experimentation with new institutional structures and arrangements, the outcomes of which cannot be fully predicted. This is a time for imaginative social innovations as well as technical innovations and – given the interdependence of the global economy – a time for monitoring, analysing and assessing national experience and results with a view to build up international co-operation.

RECOMMENDATION

Our starting point was that technological change is a social process. From that follows the need for a broad-based consensus about the impact of new technologies on the social fabric, both at the national and the international level. We therefore recommend the further development of various forms of technology assessment which should be a continuing process and in which elected legislatures should equip themselves to play an active and informed though not an exclusive role. The basic aim should be to provide information to those concerned, to promote and participate in a constructive public debate in a wide circle of institutions, thereby strengthening the democratic process through increased public understanding of, and involvement in, the process of change.

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